PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Commissioner
US Department of Commerce
United States Patent and Trademark Office, PCT
2011 South Clark Place Room CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 11 January 2001 (11.01.01)	
International application No. PCT/US00/02541	**Applicant's or agent's file reference** 742/188
International filing date (day/month/year) 01 February 2000 (01.02.00)	**Priority date** (day/month/year) 19 February 1999 (19.02.99)
Applicant CHARVAT, George, F.	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

18 August 2000 (18.08.00)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer Juan Cruz
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

Form PCT/IB/331 (July 1992)

PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 742/188	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/US00/02541	International filing date *(day/month/year)* 01 FEBRUARY 2000	Priority date *(day/month/year)* 19 FEBRUARY 1999
International Patent Classification (IPC) or national classification and IPC IPC(7): B23B 35/00 and US Cl.: 408/1R, 37, 115R		
Applicant JODA ENTERPRISES, INC.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets.

   ☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority. (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of _____ sheets.

3. This report contains indications relating to the following items:

   I ☒ Basis of the report

   II ☐ Priority

   III ☐ Non-establishment of report with regard to novelty, inventive step or industrial applicability

   IV ☐ Lack of unity of invention

   V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

   VI ☐ Certain documents cited

   VII ☐ Certain defects in the international application

   VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
18 AUGUST 2000	01 JUNE 2001
Name and mailing address of the IPEA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer For DANIEL W. HOWELL Telephone No. (703) 308-1148 Sheila Veney Paralegal Specialist Technology Center 3700

Form PCT/IPEA/409 (cover sheet) (July 1998)★

INTERNATIONAL PRELIM[redacted]RY EXAMINATION REPORT

International application No.
PC[redacted]00/02541

I. Basis of the report

1. With regard to the elements of the international application:*

[ ] the international application as originally filed

[X] the description:
pages (See Attached) , as originally filed
pages _____ , filed with the demand
pages _____ , filed with the letter of _____

[X] the claims:
pages (See Attached) , as originally filed
pages _____ , as amended (together with any statement) under Article 19
pages _____ , filed with the demand
pages _____ , filed with the letter of _____

[X] the drawings:
pages (See Attached) , as originally filed
pages _____ , filed with the demand
pages _____ , filed with the letter of _____

[X] the sequence listing part of the description:
pages (See Attached) , as originally filed
pages _____ , filed with the demand
pages _____ , filed with the letter of _____

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

[ ] the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

[ ] the language of publication of the international application (under Rule 48.3(b)).

[ ] the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

[ ] contained in the international application in printed form.

[ ] filed together with the international application in computer readable form.

[ ] furnished subsequently to this Authority in written form.

[ ] furnished subsequently to this Authority in computer readable form.

[ ] The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

[ ] The statement that the information recorded in computer readable form is identical to the writen sequence listing has been furnished.

4. [X] The amendments have resulted in the cancellation of:

[X] the description, pages NONE

[X] the claims, Nos. NONE

[X] the drawings, sheets/~~fig~~ NONE

5. [ ] This report has been drawn as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

** Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

***Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.*

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/[redacted]00/02541

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. statement

Novelty (N)	Claims	(Please See supplemental sheet)	YES
	Claims	(Please See supplemental sheet)	NO
Inventive Step (IS)	Claims	(Please See supplemental sheet)	YES
	Claims	(Please See supplemental sheet)	NO
Industrial Applicability (IA)	Claims	(Please See supplemental sheet)	YES
	Claims	(Please See supplemental sheet)	NO

2. citations and explanations (Rule 70.7)

Claims 6-10, 13, 31, 32, 34, 35, and 37-39 lack an inventive step under PCT Article 33(3) as being obvious over Koeppen. The device of Koeppen is disclosed as machining a mold, not a torque transmitting tool. It is considered to have been obvious to have used the device of Koeppen to have made such a tool, as it is apparent that the concept of machining two such opposed holes in a workpiece is notoriously old. With respect to claim 23, the particular angles which are drilled are considered to be obvious depending on the particular workpiece which is manufactured.

Claims 1 and 2 lack an inventive step under PCT Article 33(3) as being obvious over Carpinella. Figure 1 shows a headed member 38 having a shoulder which has opposed drills operating on it, such that the holes are drilled in a particular location relative to the shoulder. It is considered to have been obvious to have used this device to operate on a torque transmitting tool, as it is clear that the individual method steps are well known.

Claims 3-5, 11, 12, 14-30, 33, and 36 meet the criteria set out in PCT Article 33(2)-(4), because the prior art does not teach or fairly suggest forming the seating surface of claims 3, 4, and 11, supporting the drill with a bushing as set forth in claim 14 and 27, the combination with the tool of claim 18, the sensing element of claim 16, the particular mill of claim 24, the fixture as set forth in claim 26, and the two separate drills of claim 33 and 36.

---------- NEW CITATIONS ----------

NONE

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: Boxes I - VIII

I. BASIS OF REPORT:

This report has been drawn on the basis of the description,
page(s) 1-9, as originally filed.
page(s) NONE, filed with the demand.
and additional amendments:
NONE

This report has been drawn on the basis of the claims,
page(s) 10, 11, as originally filed.
page(s) NONE, as amended under Article 19.
page(s) NONE, filed with the demand.
and additional amendments:
Pages 12-15, filed with the letter of 07 May 2001.

This report has been drawn on the basis of the drawings,
page(s) 1-6, as originally filed.
page(s) NONE, filed with the demand.
and additional amendments:
NONE

This report has been drawn on the basis of the sequence listing part of the description:
page(s) NONE, as originally filed.
pages(s) NONE, filed with the demand.
and additional amendments:
NONE

V. 1. REASONED STATEMENTS:
The report as to Novelty was positive (YES) with respect to claims 1-39.
The report as to Novelty was negative (NO) with respect to claims NONE.
The report as to Inventive Step was positive (YES) with respect to claims 3-5, 11, 12, 14-30, 33, 36.
The report as to Inventive Step was negative (NO) with respect to claims 1, 2, 6-10, 13, 31, 32, 34, 35, 37-39.
The report as to Industrial Applicability was positive (YES) with respect to claims 1-39.
The report as to Industrial Applicability was negative (NO) with respect to claims NONE.

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International Bureau

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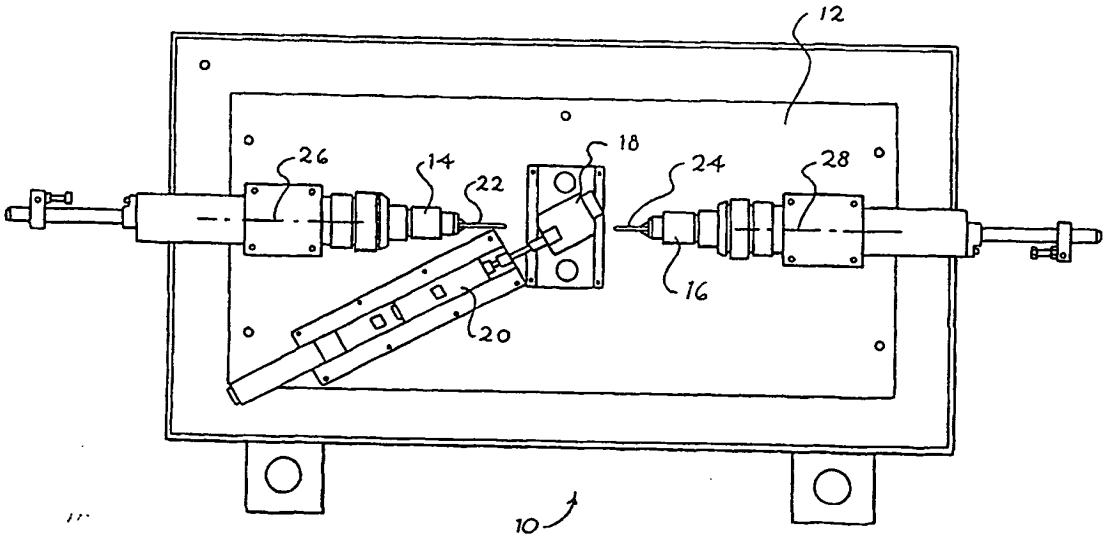
(54) Title: METHOD AND APPARATUS FOR REGISTERING A TORQUE-TRANSMITTING TOOL IN A FIXTURE AND FOR FORMING A DIAGONAL BORE IN THE TOOL



(57) Abstract

A torque transmitting tool (T) is machined by registering the torque transmitting tool (T) using a shoulder (R) between the shank (S) and the out-of-round drive portion (D) of the tool (T) as a reference. First and second seating surfaces (242, 244) are milled on first and second opposed surfaces (246, 248) of the tool (T), and then first and second bores (250, 252) are drilled into the drive stud, starting from the first and second seating surfaces (242, 244), respectively. The first and second bores (250, 252) intersect within the drive stud to form a stepped diagonal bore in the tool (T). Alternately, all machining operations are performed from one side of the tool (T).

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Method and Apparatus for Registering a Torque-Transmitting Tool in a Fixture and for Forming a Diagonal Bore in the Tool

BACKGROUND

The present invention relates to machining and registering methods well suited for use with torque-transmitting tools such as out-of-round drive studs.

U. S. Patent No. 5,644,958, assigned to the assignee of the present invention, discloses a quick release mechanism for an extension bar suitable for use with a socket wrench. This quick release mechanism utilizes a diagonally-oriented, stepped bore formed in the drive stud of the extension bar.

The machining of such diagonal bores presents manufacturing difficulties. In particular, there is a need to register the drive stud reliably with respect to the drilling axis. Poor registration can result in misplaced machined surfaces, and is therefore to be avoided. Proper location of a diagonal bore is even more difficult, because the oblique orientation of such a bore can cause the bore to deviate from the desired drilling axis, either at the start of the bore or during the drilling operation. Furthermore, when a drill is passed completely through the drive stud on a diagonal axis, there is a tendency for the drill to break as it exits the drill stud. This tendency is especially great for a stepped bore, which requires a relatively smaller diameter portion at the front of the drill.

SUMMARY

The present invention is directed both to an improved system for registering a drive stud for machining, and to improved systems for forming a diagonal bore. The invention itself is defined by the following claims, and the

following paragraphs of this section are intended as an introduction, not as a definition of the invention.

Preferred embodiments described below efficiently form a stepped bore in a drive stud by first registering the drive stud precisely with respect to a drilling axis with a fixture that engages the shoulder between the out-of-round, extreme end portion of the drive stud and the adjacent, shank portion of the drive stud. In some preferred embodiments, the stepped bore is drilled in two stages, using two drills of differing diameters that enter the drive stud from respective sides of the longitudinal axis. The bores formed by these drills meet in the interior of the drive stud to form the required step.

Other preferred embodiments form a first seating surface on the tool at a point of intersection between an exterior surface of the tool and a drilling axis that intersects this surface at an oblique angle. This seating surface is shaped to facilitate subsequent drilling operations. For example, the seating surface may be oriented substantially transverse to the drilling axis. This feature, along with the fixture described above, can be used in methods that form the diagonal bore exclusively from one side of the longitudinal axis.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a plan view of a drilling system that incorporates a first preferred embodiment of this invention.

Figure 2 is a side view of the drilling system of Figure 1.

Figure 3 is an enlarged cross-sectional view showing a fixture included in the drilling system of Figures 1 and 2.

Figure 4 is a plan view of a second preferred embodiment of the drilling system of this invention.

Figure 5 is a block diagram of a method practiced by the drilling system of Figure 4.

Figures 6, 7 and 8 are partial cross-sectional views showing three stages in the formation of a diagonal bore.

Figure 9 is a block diagram of a method of another embodiment of this invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Turning now Figures 1 and 2, a drilling system 10 incorporates a preferred embodiment of this invention. The drilling system 10 includes a table 12 that supports first and second drilling heads 14, 16, a fixture 18, and a clamp 20. The first and second drilling heads 14, 16 support first and second drills 22, 24 aligned with respective first and second drilling axes 26, 28. The first and second drilling heads 14, 16 are rotated in the conventional manner about the respective drilling axes 26, 28 by motors (not shown) and are moved axially along the respective drilling axes 26, 28 by respective air cylinders (not shown).

The clamp 20 supports a torque-transmitting tool T in the fixture 18 for machining.

Figure 3 shows a cross-sectional view of the fixture 18 with the tool T clamped in place. As shown in Figure 3, the tool T includes a drive stud that is made up of a shank portion S and an out-of-round drive portion D. In this embodiment, the shank portion S has a circular cross-section and the drive portion D has substantially a square cross-section. The transition between the shank S and the drive portion D comprises a shoulder R that defines a reference point at any desired point on the shoulder R.

The fixture 18 defines an out-of-round opening 30 that is shaped to receive the drive portion D, and a protruding element 32 that is shaped to engage the reference point on the shoulder R. Note that the opening 30 is deeper than the drive portion D is long such that the shoulder R registers the tool T with respect to the protruding element 32, and not the end of the drive portion D.

As shown in Figure 3, the fixture 18 also supports first and second drilling bushings 34, 36. Each of the bushings 34, 36 is aligned with the respective drilling axis 26, 28 and is sized to receive closely and support the respective drill 22, 24. Preferably the bushings 34, 36 are formed of a hard material such as silicon carbide, and they are provided with oblique ends 38, 40 shaped to conform closely to the respective surfaces of the tool T and

thereby to provide support for the respective drills 22, 24 to a position closely adjacent to the tool T.

Figure 4 shows a drilling system 100 that incorporates a second preferred embodiment of this invention. The drilling system 100 is similar to the drilling system 10 in that it includes first and second drilling heads 102, 104 positioned as described above with respect to a fixture 106. The drilling heads 102, 104 and the fixture 106 can be identical to the drilling heads 14, 16 and the fixture 18 described above.

In addition, the drilling system 100 includes first and second milling heads 108, 110. The first and second drilling heads 102, 104 are arranged along a first line 120, and the first and second milling heads 108, 110 are arranged along a second line 122. In this embodiment, the lines 120, 122 intersect at an angle of about 60°.

The fixture 106 and the associated clamp 112 are mounted on a plate 114 that is rotatably mounted with respect to the remainder of the system 100. The plate 114 can be rotated about the longitudinal axis L of the tool T between two positions that are separated by an angle of 180°. In the first position, the drills of the first and second drilling heads 102, 104 are aligned with the bushings 116, 118, as shown in Figure 4. In the second position (not shown), the mills of the first and second milling heads 108, 110 are aligned with the bushings 116, 118 (Figure 4).

Figure 5 provides a flow chart of a milling method practiced by the system 100 of Figure 4, and Figures 6-8 provide cross-sectional views of the tool T at three successive stages of the milling process.

In block 200 of Figure 5, the tool (an extension bar in this example) is registered in the fixture. As described above, the shoulder R between the shank S and the drive portion D is used as a reference point in order precisely to position the tool in the fixture. In block 202, first and second seating surfaces are milled on first and second surfaces of the drive stud. In Figure 6, the first and second seating surfaces are indicated at 242 and 244, respectively. As shown in Figure 6, the seating surfaces 242, 244 are formed in first and second surfaces 246, 248, respectively of the tool T. These

surfaces 246, 248 are disposed on respective sides of the longitudinal axis L, and are parallel to one another in the view of Figure 6. In this embodiment, the seating surfaces 242, 244 are formed by an end mill as planar surfaces oriented at right angles to the respective drilling axes 226, 228. After block 202 the plate 114 is indexed to bring the fixture bushings into alignment with the drilling heads.

In alternative embodiments the seating surfaces 242, 244 can be formed by machining operations along other axes, e.g. perpendicular to the surfaces 246, 248 or to the axes 226, 228. The seating surfaces 242, 244 may take many shapes. For example, they may be perpendicular to the axes 226, 228 at the point of intersection with the axes 226, 228, but otherwise curved (e.g. spherically concave or cylindrically concave), or they may form a corner that locates a drill. In all cases, the seating surfaces 242, 244 are shaped to reduce any tendency of the drill bit of a subsequent drilling operation to wander or skate away from the intended drilling axis, as compared with the original surfaces 246, 248. In some cases (e.g. the cylindrically curved or the corner surfaces described above), the seating surface will not be rotationally symmetrical about the drilling axis.

Continuing with Figure 5, in block 204 a first bore is drilled from the first seating surface into the tool, and in block 206, a second bore is drilled from the second seating surface into the tool to intersect the first bore. Figure 7 shows the tool T at an intermediate stage in the formation of the first and second bores 250, 252. Note that the first bore 250 has a larger diameter than the second bore 252, and that the respective drilling axes 226, 228 are co-linear. Figure 8 shows the tool T at a later stage of manufacture, at which the bores 250, 252 have intersected to form a stepped bore that extends completely through the tool T and defines a shoulder 254. Preferably, the first and second bores 250, 252 are drilled in a manner such that the drilling operations overlap in time to reduce the total time required to form the stepped bore. As shown in Figure 8, the angle $\alpha 1$ between the first surface 246 and the first drilling axis 26 is equal to the angle $\alpha 2$ between the second surface 248 and the second drilling axis 28. The angles $\alpha 1$ and $\alpha 2$ are both

oblique angles. If desired, either bore 250, 252 can be drilled before the other.

Continuing with Figure 5, the extension bar is then removed from the fixture in block 208.

Figure 9 relates to another preferred method of this invention. The method of Figure 9 can be used to drill a stepped bore similar to the bore shown in Figure 8, but in the method of Figure 9 all drilling and milling operations proceed from only a single side of the tool being formed.

As shown in block 300 of Figure 9, a tool is first registered in a fixture. The tool can be the tool T described above, and the fixture may be identical to the fixture shown in Figure 3. However, since all drilling operations proceed from a single side of the tool, the bushing 36 is not needed. As described above, the shoulder between the drive portion D and the shank S provides a preferred registration surface for the fixture.

Next, at 302, a seating surface is milled on an exterior surface of the tool from side S1. The seating surface may be substantially identical to the seating surface 242 of Figure 6, and the side S1 may be the surface 246 of Figure 6. At 304, the seating surface is then center drilled from side S1. A center drilling operation forms a small conical recess in the seating surface to assist in centering a drill in subsequent drilling operations.

Because the seating surface formed at 302 in this example is substantially transverse to the drilling axis of the center drill of 304, the center drill of 304 consistently and reliably forms the center drill recess at the desired intersection of the drilling axis and the seating surface. The drilling axis may be oriented as shown at 226 in Figure 6, and the center drill recess is formed at the intersection of the drilling axis 226 and the seating surface 242.

At 306, a larger diameter drill is used to drill part of the larger bore from side S1. This drill is centered by the center drill recess formed at 304. Next, at 308, a smaller diameter drill is used to form part of the smaller bore, again proceeding from side S1 along the drilling axis. At 310, the larger bore is completed from side S1 with a drill of the same diameter as that used at 306. At 312, a smaller drill is used to complete formation of the smaller bore from

side S1. The drill used at 312 is the same diameter as that used at 308. Finally, at 314, the tool is removed from the fixture. If desired, a step drill may optionally be used between blocks 312 and 314 to provide the final finish and shape to the step between the larger and smaller bores.

The method of Figure 9 can be implemented using a conventional, numerically controlled, indexed milling machine and the tool registration fixture described above. The registration fixture provides all of the advantages described in conjunction with the first and second embodiments, and the seating surface assists in properly locating the center drill recess.

It should be apparent from the foregoing discussion that the drilling systems described above precisely register the tool using the shoulder between the out-of-round drive portion and the shank portion of the drive stud. The drilling system 10 operates similarly to the drilling system 100, except that no seating surfaces 242, 244 are formed. The methods described above in conjunction with the systems 10, 100 can readily be automated in quick and reliable systems that provide little tool breakage since the drills are well-supported to a point closely adjacent the tool, and the drills are never caused to exit the tool at an oblique angle. By using the seating surfaces 242, 244, consistent results can be achieved using a preferably substantially constant speed of drill advance. The registration techniques described above may be used separately from the drilling techniques, and vice-versa.

The widest variety of machine tools and mechanisms for controlling the movement of these machine tools can be used. For example, pneumatic, hydraulic, and electric power systems can be used. Conventional numerically controlled machine tool techniques can be used to automate the methods described above. In alternative embodiments of this invention, either the machine tools can be moved along any suitable direction to bring successive machine tools into alignment with the drilling axes, or the fixture can be moved along any suitable direction to achieve a similar result. Any suitable combination of rotational and/or translational movements can be used. This invention is not limited to use with the specific machine tools or the specific workpieces described above.

As used herein, the term "drive stud" is intended broadly to encompass the out-of-round portion and adjacent portions of a torque transmitting tool at intermediate stages of manufacture.

The term "oblique" is intended broadly to encompass acute angles between 0 and 90 degrees.

The term "to machine" is intended broadly to encompass any material removal method including drilling, milling, turning, grinding and electrical discharge machining, for example.

The term "machine tool" is intended broadly to encompass any tool for machining as defined above.

The term "operative position" is intended to refer to a relative position between a machine tool and a workpiece that orients the machine tool to a desired alignment with the workpiece. The operative position can be achieved by moving either the machine tool, or the fixture in which the workpiece is registered, or both to achieve the desired alignment.

The term "machined surface" is intended broadly to encompass a surface formed by any machining activity or any machine tool, including those described above.

The term "reference surface" is intended broadly to encompass a point-like surface, a line-like surface, or a surface that extends substantially in two or three dimensions.

The term "shoulder" is intended broadly as applied to a tool to encompass any part of the transitional surface between the shank portion and the drive portion of the tool, including but not limited to portions of the transitional surface immediately adjacent to the shank portion and the drive portion.

The term "fixture" is intended broadly to encompass one or more elements that stabilize the workpiece in the desired orientation. A fixture may include multiple discrete elements that are separately mounted to a reference element, and the fixture may contact the workpiece at only a few discrete points rather than receiving the workpiece as illustrated. There is no requirement that a fixture include drill bushings as shown, whether or not drill

bushings are used. In some embodiments, the fixture may register a tool without physical contact with a reference surface of the tool, as for example when the position of the reference surface is sensed optically rather than by physical contact.

The foregoing detailed description has described only a few of the many forms that this invention can take. For this reason, this detailed description is intended only by way of illustration, and not by way of limitation. It is only the following claims, including all equivalents, that are intended to define the scope of this invention.

Claims

1. A method for registering a torque-transmitting tool comprising:

(a) providing a torque-transmitting tool comprising a shank portion, an out-of-round drive portion, and a shoulder intermediate the shank portion and the drive portion;

(b) referencing at least one machined surface of the tool drive with respect to at least one reference surface on the shoulder.

2. The method of Claim 1 wherein (b) comprises

(b1) registering the tool in a fixture that engages the reference surface on the shoulder; and

(b2) machining the at least one machined surface of the tool.

3. A method for forming a diagonal bore in a torque-transmitting tool comprising a longitudinal axis and a first surface on one side of the longitudinal axis, said method comprising:

(a) forming a seating surface on the tool at a point of intersection between the first surface and a drilling axis that intersects the first surface at an oblique angle, said seating surface oriented substantially transverse to the drilling axis at a point where the drilling axis intersects the seating surface; and

(b) drilling a bore in the tool along the drilling axis through the seating surface.

4. A method for forming a diagonal bore in a torque-transmitting tool comprising a longitudinal axis and a first surface on one side of the longitudinal axis, said method comprising:

(a) forming a seating surface on the tool at a point of intersection between the first surface and a drilling axis that intersects the first surface at an oblique angle, said seating surface being rotationally asymmetrical about the drilling axis and shaped to reduce any tendency of a

drill bit to skate in a subsequent drilling operation along the drilling axis as compared with the first surface; and

(b) drilling a bore in the tool along the drilling axis through the seating surface.

5. The method of Claim 3 or 4 further comprising:

(c) center drilling the seating surface along the drilling axis after (a) and before (c).

6. A method for forming a diagonal bore in a torque-transmitting tool comprising a longitudinal axis and first and second surfaces on different sides of the longitudinal axis, said method comprising:

(a) drilling a first bore in the tool from the first surface along a first drilling axis, said first drilling axis intersecting the first surface at a first oblique angle; and

(b) drilling a second bore in the tool from the second surface along a second drilling axis, said second drilling axis intersecting the second surface at a second oblique angle, said first and second drilling axes oriented such that the first and second bores meet in the tool.

7. The method of Claim 6 wherein the first and second surfaces are substantially parallel to one another.

8. The method of Claim 6 wherein the first bore is larger in diameter than the second bore, and wherein the first and second bores meet at a shoulder in the tool.

9. The method of Claim 6 wherein the first and second drilling axes are substantially co-linear.

10. The method of Claim 6 wherein the first and second oblique angles are substantially equal to one another.

11. The method of Claim 6 further comprising

forming a first seating surface at a point of intersection between the first surface and the first drilling axis prior to (a).

12. The method of Claim 11 further comprising

forming a second seating surface at a point of intersection between the second surface and the second drilling axis prior to (b).

13. The method of Claim 6 wherein drilling operations of (a) and (b) overlap in time.

14. The method of Claim 6 wherein (a) comprises

supporting a first drill with a first drill bushing aligned with the first drilling axis to a position closely adjacent to the first surface.

15. The method of Claim 14 wherein (b) comprises

supporting a second drill with a second drill bushing aligned with the second drilling axis to a position closely adjacent to the second surface.

16. A system for machining a torque-transmitting tool, said tool comprising a shank, an out-of-round drive portion, and a shoulder therebetween, said system comprising:

at least one machine tool; and

a fixture selectively positioned with respect to each machine tool, said fixture comprising at least one sensing element configured to sense the shoulder to register the tool with respect to the fixture and each machine tool.

17. The system of Claim 16 wherein the fixture further comprises an out-of-round opening configured to receive the drive portion

18. A system for machining a diagonal bore in a drive stud of a torque-transmitting tool, said tool comprising a longitudinal axis and first and second surfaces on different sides of the longitudinal axis, said system comprising:

a fixture configured to hold the tool in a selected position;

a first drill oriented with respect to the fixture when in an operative position to drill a first bore in the tool from the first surface along a first drilling axis, said first drilling axis intersecting the first surface at a first oblique angle;

a second drill oriented with respect to the fixture when in an operative position to drill a second bore in the tool from the second surface along a second drilling axis, said second drilling axis intersecting the second surface at a second oblique angle, said first and second drilling axes oriented such that the first and second bores meet in the tool.

19. The invention of Claim 18 wherein the first and second surfaces are parallel to one another.

20. The method of Claim 18 wherein the first and second bores meet at a shoulder in the tool.

21. The method of Claim 18 or 20 wherein the first and second drilling axes are substantially co-linear.

22. The method of Claim 21 wherein the first bore is larger in diameter than the second bore.

23. The method of Claim 18 wherein the first and second oblique angles are substantially equal to one another.

24. The invention of Claim 18 further comprising:

a first mill oriented with respect to the fixture when in an operative position to form a first seating surface at a point of intersection between the first surface and the first drilling axis.

25. The invention of Claim 24 further comprising:

a second mill oriented with respect to the fixture when in an operative position to form a second seating surface at a point of intersection between the second surface and the second drilling axis.

26. The invention of Claim 18 wherein the tool comprises a shank and a shoulder between the shank and at least one surface of the drive stud, and wherein the fixture is configured to engage the drive stud and to use the shoulder to register the tool with respect to the fixture and the drills.

27. The invention of Claim 18 wherein the fixture comprises a first drill bushing positioned closely adjacent the first surface and aligned with the first drilling axis to support the first drill.

28. The invention of Claim 27 wherein the fixture comprises a second drill bushing positioned closely adjacent the second surface and aligned with the second drilling axis to support the second drill.

29. The invention of Claim 27 wherein the first drill bushing comprises an oblique end substantially aligned with the first surface.

30. The invention of Claim 28, wherein the second drill bushing comprises an oblique end substantially aligned with the second surface.

31. A method for forming a diagonal bore in a torque-transmitting tool comprising a longitudinal axis and first and second surfaces on different sides of the longitudinal axis, said method comprising:

(a) drilling a first bore in the tool from the first surface along a first drilling axis, said first drilling axis intersecting the first surface at a first oblique angle; and

(b) drilling a second, smaller bore in the tool from the first surface along the first drilling axis, said second bore forming with the first bore a step within the tool, said second bore passing through the second surface at a second oblique angle.

32. The method of Claim 31 wherein (a) comprises drilling the first bore in two drilling operations.

33. The method of Claim 32 wherein (a) comprises drilling the first bore with two separate drills in said two drilling operations.

34. The method of Claim 32 or 33 wherein at least part of the second, smaller bore of (b) is drilled between said two drilling operations.

35. The method of Claim 31 wherein (b) comprises drilling the second, smaller bore in two drilling operations.

36. The method of Claim 32 wherein (b) comprises drilling the second smaller bore with two separate drills in said two drilling operations.

37. A method for forming a diagonal bore in a torque-transmitting tool comprising a longitudinal axis and first and second surfaces on different sides of the longitudinal axis, said method comprising:

(a) forming a first part of a first, larger bore in the tool from the first surface along a first drilling axis, said first drilling axis intersecting the first surface at a first oblique angle;

(b) forming a first part of a second, smaller bore in the tool from the first surface along the first drilling axis;

(c) forming a second part of the first, larger bore in the tool form the first surface along the first drilling axis; and

(d) forming a second part of the second, smaller bore in the tool from the first surface along the first drilling axis, said second part of the second, smaller bore passing through the second surface at a second oblique angle.

38. The method of Claim 37 wherein different drills are used in (a) and (c) and different drills are used in (b) and (d).

39. The method of Claim 37 wherein (a) is performed before (c), wherein (b) is performed before (d), and wherein (a) is performed before (d).

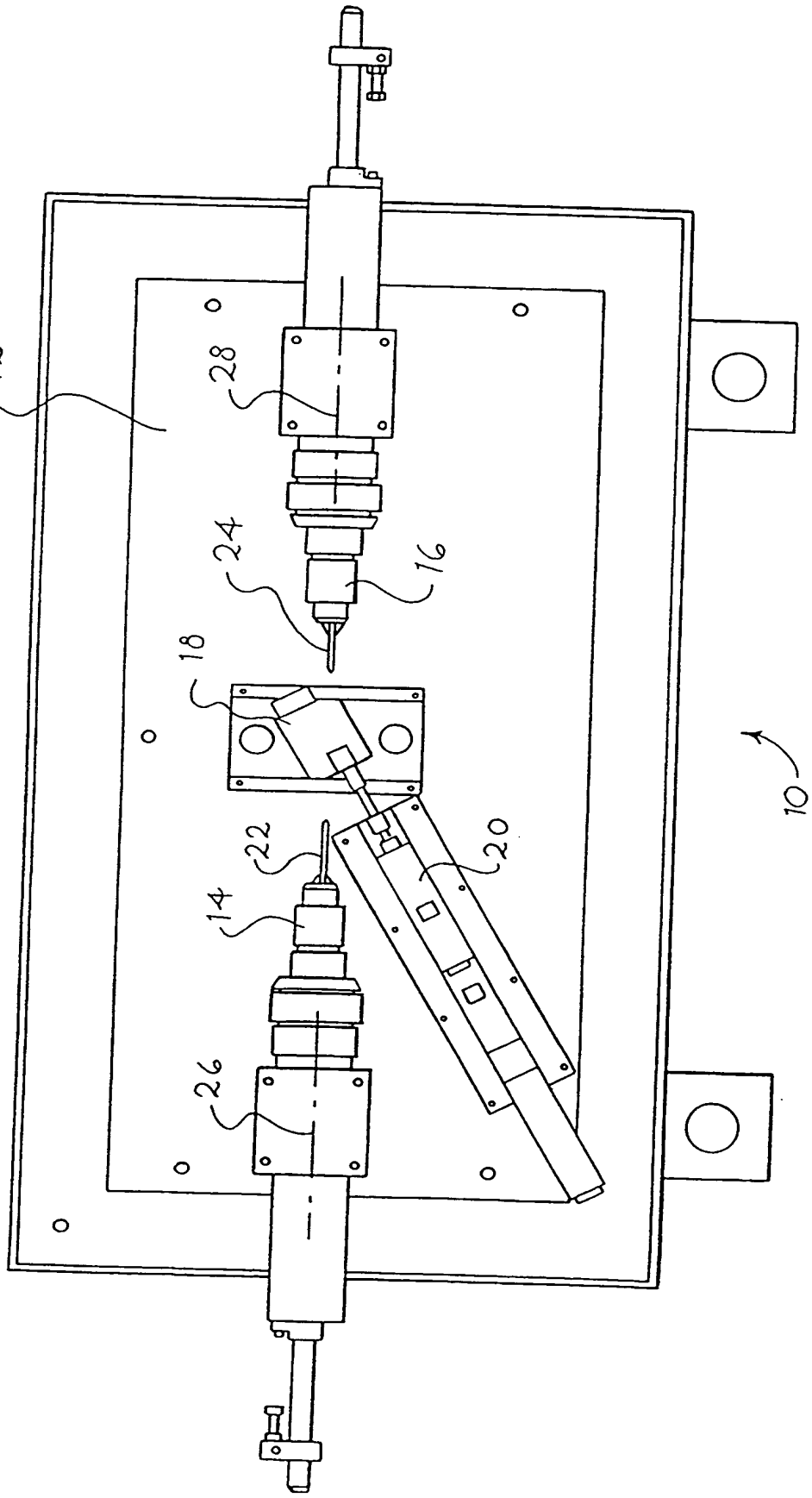


Fig. 1

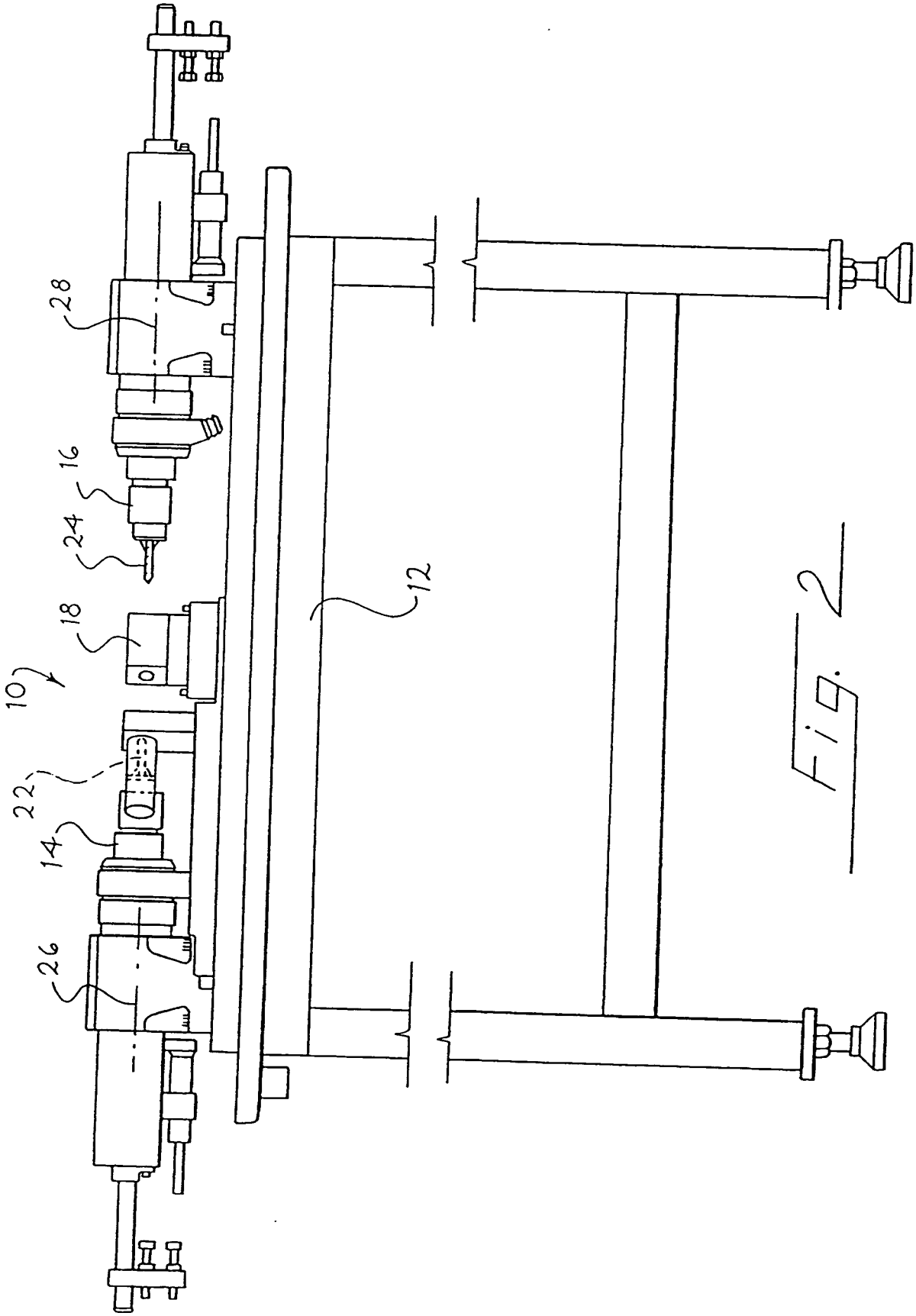
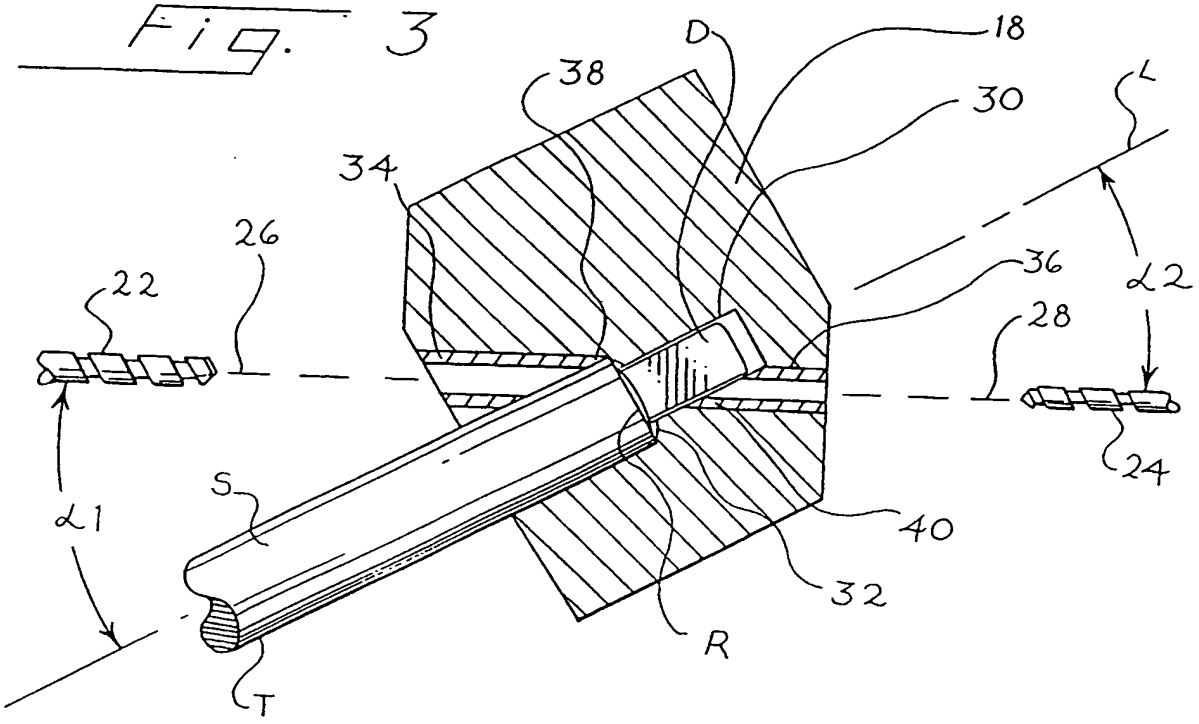


Fig. 2

Fig. 3



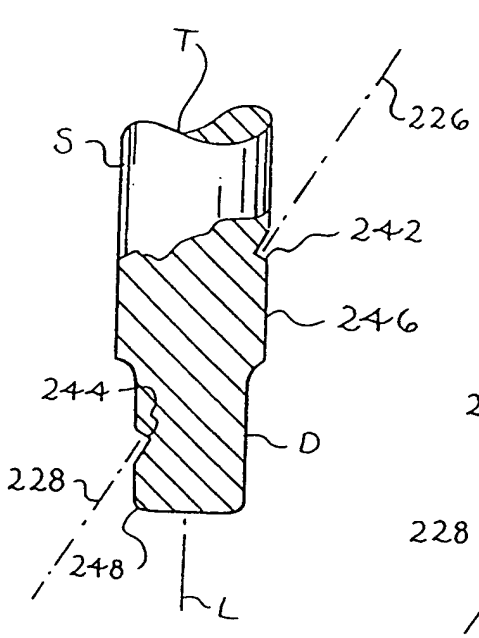


Fig. 6

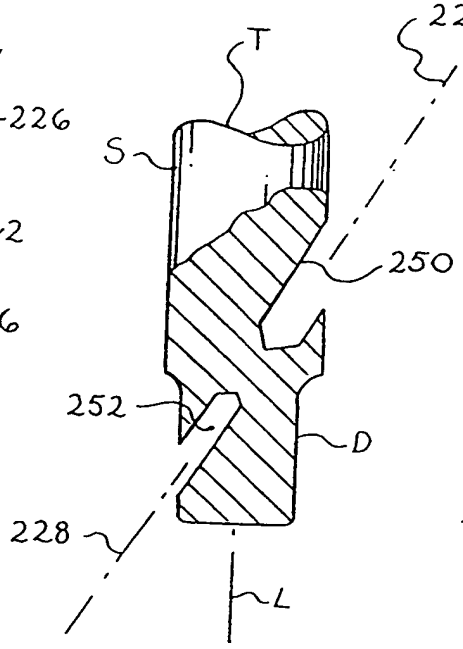


Fig. 7

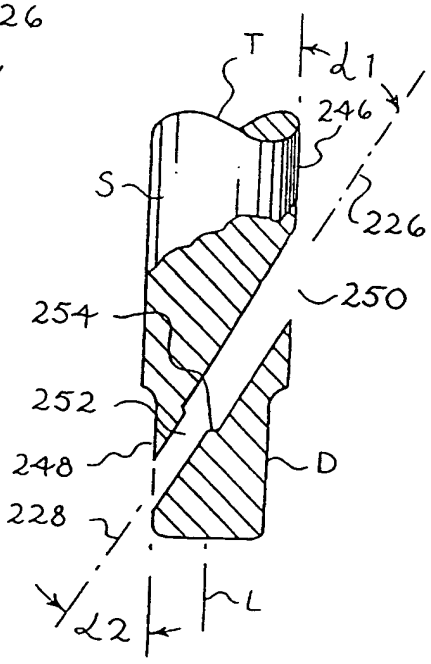


Fig. 8

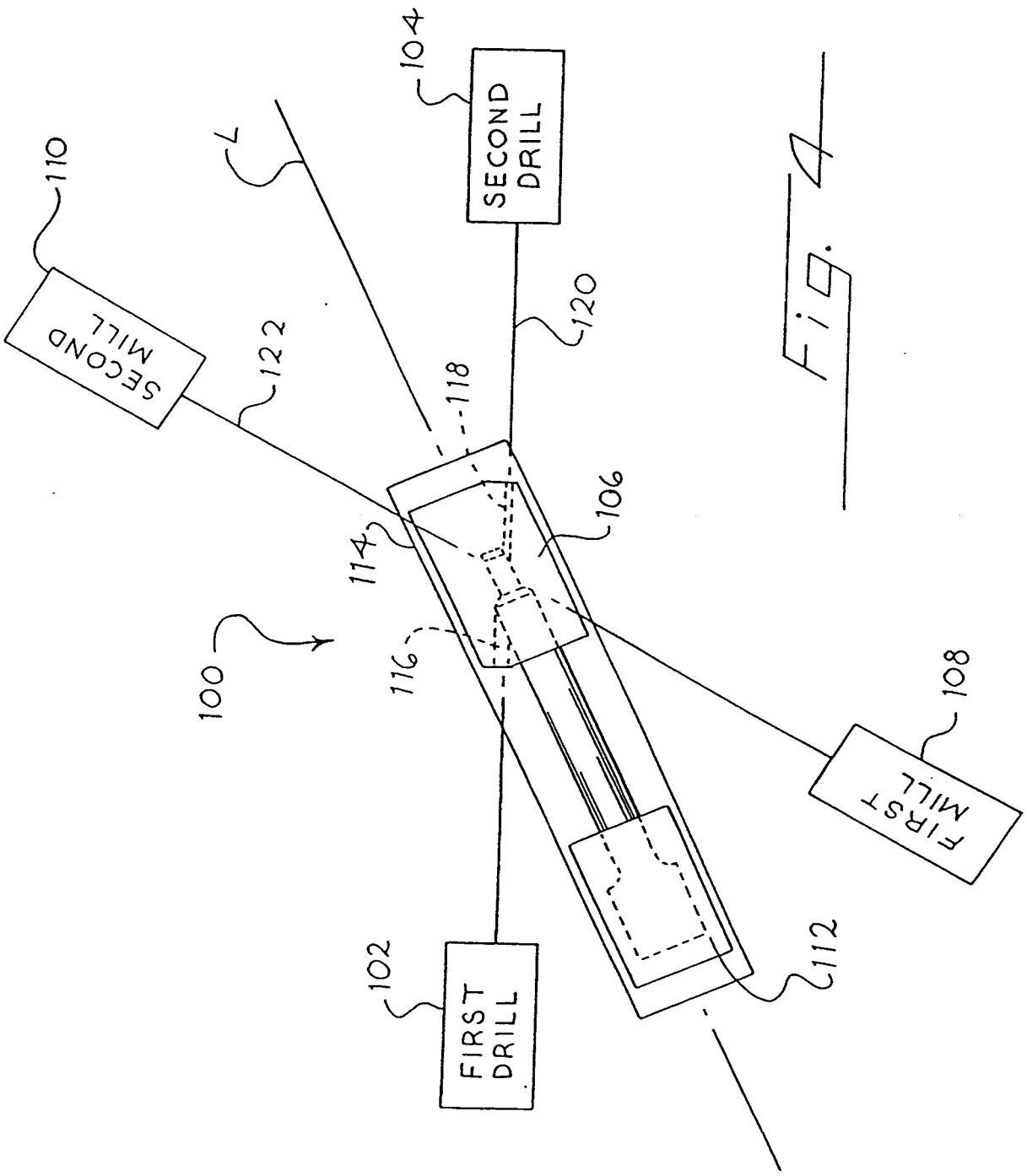

104
SECOND DRILL
110
SECOND MILL
122
120
118
106
114
116
100
108
FIRST MILL
102
FIRST DRILL
112

Fig. 4

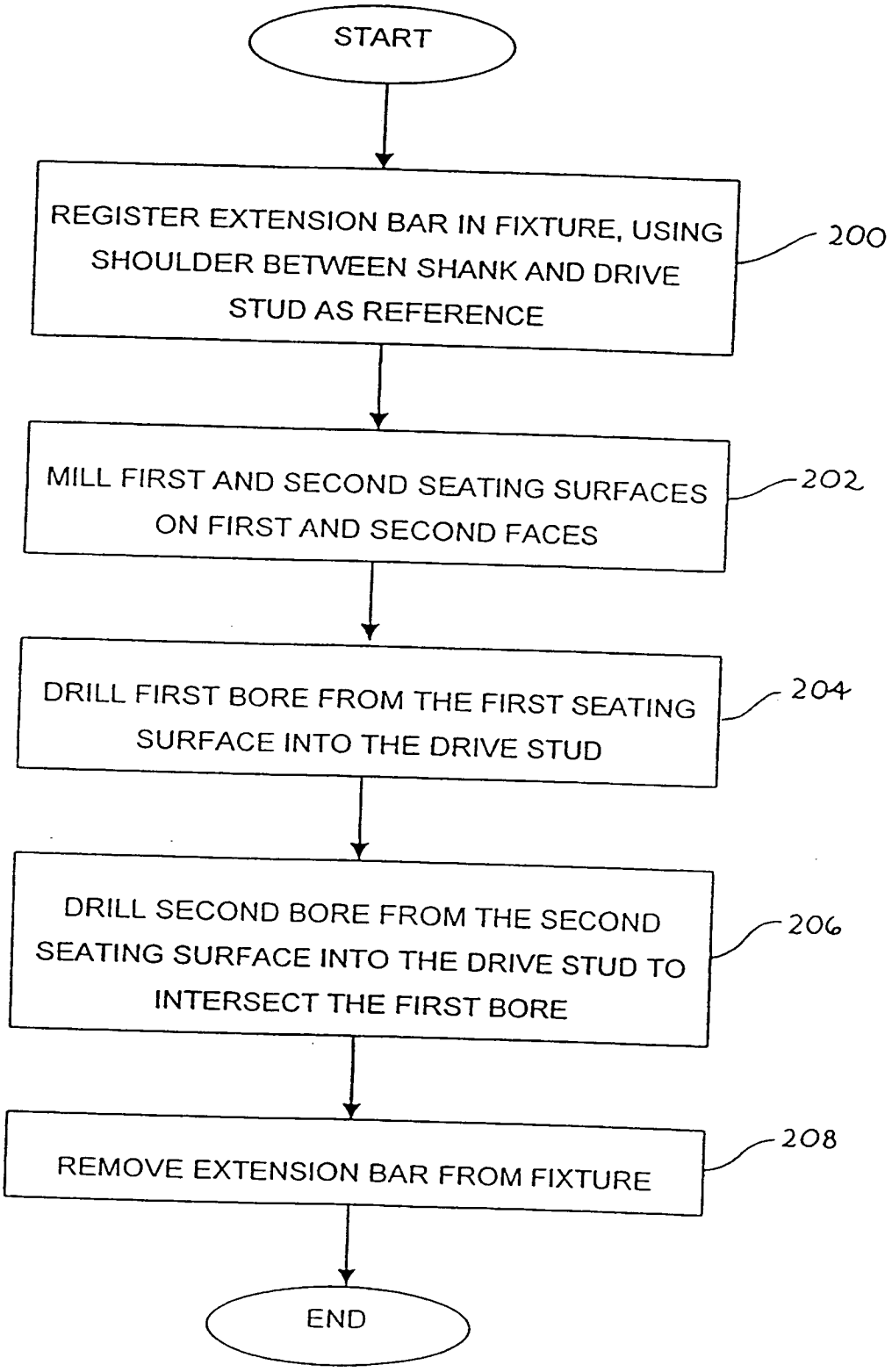

START
REGISTER EXTENSION BAR IN FIXTURE, USING SHOULDER BETWEEN SHANK AND DRIVE STUD AS REFERENCE
200
MILL FIRST AND SECOND SEATING SURFACES ON FIRST AND SECOND FACES
202
DRILL FIRST BORE FROM THE FIRST SEATING SURFACE INTO THE DRIVE STUD
204
DRILL SECOND BORE FROM THE SECOND SEATING SURFACE INTO THE DRIVE STUD TO INTERSECT THE FIRST BORE
206
REMOVE EXTENSION BAR FROM FIXTURE
208
END

Fig. 5

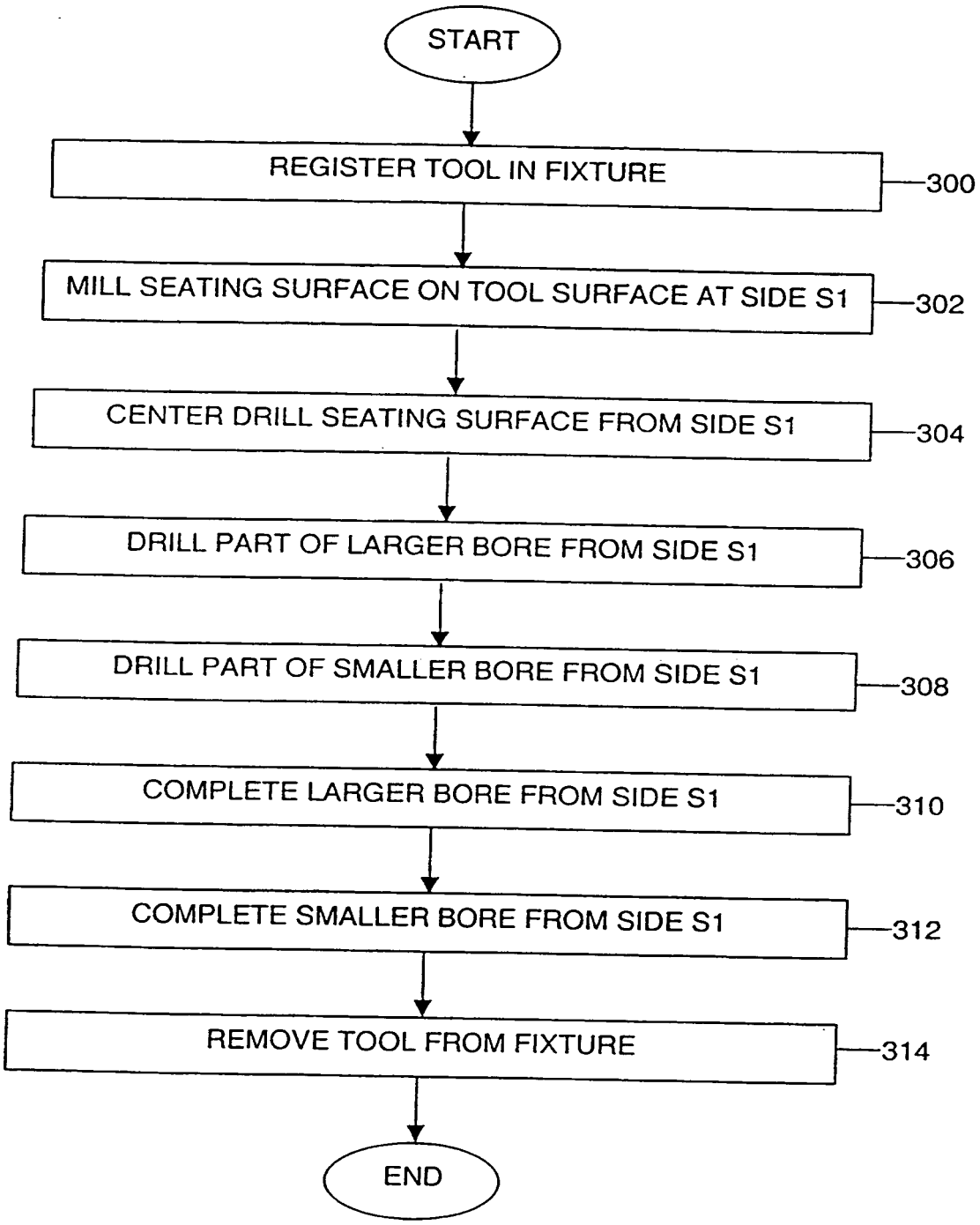

START
REGISTER TOOL IN FIXTURE
300
MILL SEATING SURFACE ON TOOL SURFACE AT SIDE S1
302
CENTER DRILL SEATING SURFACE FROM SIDE S1
304
DRILL PART OF LARGER BORE FROM SIDE S1
306
DRILL PART OF SMALLER BORE FROM SIDE S1
308
COMPLETE LARGER BORE FROM SIDE S1
310
COMPLETE SMALLER BORE FROM SIDE S1
312
REMOVE TOOL FROM FIXTURE
314
END

Fig. 9

INTERNATIONAL SEARCH REPORT

International application N .
PCT/US00/02541

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :B23B 35/00
US CL : 408/1R, 37, 115R

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 408/1R, 37, 115R, 115B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

none

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

none

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim N .
X ---- Y	US 754,321 A (KOEPPEN) 08 March 1904, see figures 1-6	18-22 --------- 6-10, 13, 23, 31, 32, 34, 35, 37-39
Y	US 2,462,035 A (CARPINELLA) 15 February 1949, see figures 1-4	1, 2

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion f the international search 07 APRIL 2000	Date of mailing of the international search report 18 APR 2000
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer DANIEL W. HOWELL Telephone No. (703) 308-1148

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Form PCT/ISA/210 (second sheet) (July 1998)*